B.E. (CE) Part-II 3rd Semester Examination, 2009

Solid Mechanics-I

(AM-301)

Time : 3 hours **Full Marks : 70**

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
The questions are of equal value.
Two marks are reserved for neatness in each half.

FIRST HALF

1. a) For a thin-walled pressure vessel, prove the expression
$$\frac{\sigma_1}{r_1} + \frac{\sigma_2}{r_2} = \frac{p}{t}$$
the symbols having their usual significance.

   b) A double riveted double cover butt joint in plates of 16 mm thickness is made with 25 mm diameter rivets at 100 mm pitch. Compute the pull per pitch length at which the joint will fail, and hence work out the efficiency of the joint. Draw a neat sketch of the joint.
Permissible stresses are $\sigma_t = 150\ MN/m^2$, $\sigma_s = 102.5\ MN/m^2$, $\sigma_c = 236\ MN/m^2$.

2. a) Write down, without proof, the expression for computing horizontal shear stress in beams and explain the symbols clearly.

   b) A beam has a T-shaped cross-section, flange 200 mm wide and 50 mm thick and web 200 mm deep and 50 mm thick. It is subjected, to a vertical shear force of 100 kN at a section. Moment of inertia of the section about the horizontal neutral axis is $0.0001134\ m^4$. Sketch the shear stress distribution across the section showing the values at significant points.

3. a) Write down, without proof, the simple bending formula for finding the bending stress at a particular fibre, of a beam section, the material having a Young's modulus E.

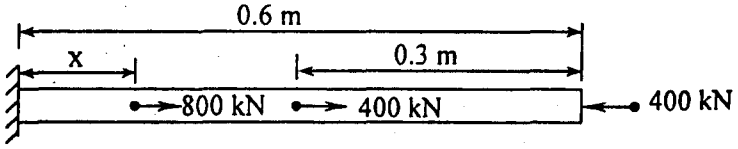
   b) A beam has a I-section with unequal flanges and is simply supported at the ends subjected to a u.d.l over its entire span. The top flange is 100 mm x 30 mm, bottom flange 120 mm x 50 mm and the web 120 mm x 30 mm. If the beam is 8 m long, find the intensity of u.d.l. The maximum permissible bending stress in tension is $30\ MN/m^2$ and that in compression is $45\ MN/m^2$. What are the actual maximum bending stresses set up in the section?

4. A solid steel shaft is subjected to a torque of 45 kN-m. If the angle of twist is 0.5 degree per metre length of the shaft and the shear stress is not to exceed 90 MN/m^2. find a suitable diameter of the shaft and the maximum shear stress set up.

5. A wooden beam 15 cm wide and 20 cm deep is rein forced at the bottom by a steel plate 15cm wide and 1cm thick. If the allowable stress in timber is 6 MN/m^2, find the moment of resistance of the beam if $E_S = 15\,E_W$.

SECOND HALF

6. A prismatic steel bar having cross sectional area A = 500 mm^2 is subjected to axial loads as shown in figure. Neglecting localized irregularities in stress distribution find out at what distance 'x' from the fixed support the 800 kN load should be applied to maintain no change in the length of the bar. (E_S = 200 GPa).

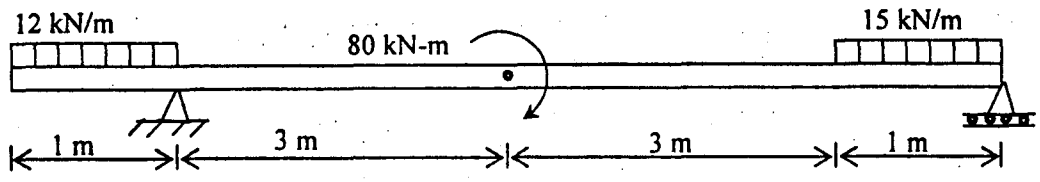


7. A steel rod 75 cm long has a cross-sectional area of 12 cm^2 over 40cm of its length and 16 cm^2 over the remaining length. At a temperature T = 20°C the rod fits exactly between unyielding walls at its two ends. Compute the maximum compressive stress that will exist in the rod at T = 50°C. Take $\alpha_s = 12 \times 10^{-6}$°C.

8. In construction of pre-stressed concrete beams, the reinforcing steel bars are initial stretched with a stress of σ_0 by application of some external pulling device and at this condition concrete is poured around the steel bars. After complete setting of concrete external pulling device is removed and the steel and concrete remain together in a prestressed condition. If the moduli of elasticity of steel and concrete are in the ratio 12:1 and their cross sectional areas are in the ratio 1:15, what are the final residual stress in steel and concrete in terms of σ_0.

9. A prismatic steel bar of length 80 cm and diameter 2 cm hangs vertically under its own weight. How much strain energy is stored in the bar? Take specific gravity of steel is 7.6.

10. Draw the S.F and B.M. diagram for the loaded beam as shown in the figure.



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